IntelliCable Interface Specification

Protonex Technology Corp.

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Specification Version Information

Version 26	- Added the Generic Properties field to the Device ID block - Added the new blocks for Load Data, Source Data, Generator Data, Battery Data and Smbus Data.

Document Revision Information

Revision 34	- Updated Spec with new vendor IDs - Added 'Product Specific 1' bit to Unique Properties 2 field - Added Document Revision Information table
Revision 35	- Added Kinetic Icon entry
Revision 36	- Changed "Cable ID" to "Device ID" in all places
Revision 37	- Added Product Specific Bit 2 - Changed a few more "Cable ID" to "Device ID" that were missed

Introduction

As power managers introduce output ports with programmable voltages, a real hazard of over or under powering equipment is inherent. If powered equipment is plugged into the port prior to setting the output voltage, it is very likely that a power mismatch between power manager and load will occur, and very often the powered equipment will be damaged or destroyed.

The IntelliCable vastly reduces the possibility of equipment damage, by providing information tied to each power cable, indicating to the Power Manager what its settings and activities must be in order to safely and effectively power the associated gear.

This specification is written with the following goals:

1. The specification is vendor-independent and promotes interoperability, and yet permits vendor innovation and differentiation.
2. The specification is not tied to a particular device or port.
3. The specification is designed to be extensible, so additional functionality can easily be added while maintaining backward compatibility with equipment and cables designed to prior versions of the specification
4. The Document Revision is not directly tied to the Implementation Revision. Should the document be updated but no new fields added, then only the Document Revision will be updated. Adding new functionality requires both the Document and Implementation Revisions to be updated. This allows the

document to change without updating firmware to take into account a new specification number where nothing changes.

Layer 1 – Physical

Each IntelliCable shall identify its capabilities and needed output using a 1-Wire storage and signaling device. Some informative sites are listed below:

- Dallas Semi / Maxim – http://www.maxim-ic.com/products/1-wire/
- 1-Wire industry standards – http://www.1wire.org

A typical IntelliCable will use a simple memory device, such as a DS2431. Other cables may use 1-Wire devices with built-in sense and control functions, such that they can power multiple load devices, or add value through sensing or indicating.

All multi-byte data (such as voltages and currents) are sent most significant byte first.

Layer 2 – Media Access

Access to the cable is in accordance with the 1-wire specifications. The power manager is always the 1-wire master, and the cable incorporates one or more 1-wire slave devices.

Layer 3 – Information (Common)

The following information is common to all IntelliCable devices:

Device ID

The Device ID information block is located at offset 0 in the memory device, and shall use the following format:

Offset	Size	Values	Description	Notes
00	1 Byte	Block Dependant (fah max)	ID Block size, in bytes, minus checksum and End Indicator.	Permits ID block to grow, so pwr mgr can skip over unknown fields
01	1 Byte	01h	Block Identifier	Indicates that this is a Device ID block.
02	2 Bytes	0000-ffffh	Vendor ID	
04	2 Bytes	0000-ffffh	Device ID	Vendor Specific
06	2 Bytes	0000-ffffh	Serial Number	
08	16 Bytes	Null terminated ASCII	Cable Name	Display name for cable or powered equipment.
24	1 Byte	00-ffh	Intellicable Spec Version	Version of the Intellicable Spec that this cable adheres too
25	2 Bytes	0000-ffffh	Serial Number (Upper 16-bits)	
27	12 Bytes	Null terminated ASCII	Part Number	Part number identification for this cable
39	2 Bytes	00-ffffh	Revision Number	Revision of this cable's definition file
41	12 Bytes	Null terminated ASCII	Programmed by	The MAC address of the computer this cable was programmed by
53	4 bytes	See Description	Generic Properties	See description
57	1 Byte	00-ffh	8-bit CRC	x8 + x2 + x + 1 of all ID bytes up to the byte prior to this one.

58	1 Byte	A5h	End Indicator	Permits checking that size byte was read correctly.

Offset 00 – ID Block size

This byte field, an unsigned integer, indicates the total number of header bytes, minus the final checksum and ID End Indicator. This permits the addition of fields following the Cable Name in future versions of the specification, without breaking earlier implementations.

If the power manager reads a device ID Block size larger than the number of fields it knows how to decode, it must use the first fields (the one it knows the function of), and then skip the remaining fields, except that it must include the skipped fields in calculating its checksum.

Offset 01 – Block Identifier

This byte field, an unsigned integer with value 01h, indicates that this is a Device ID block. Since no specific block order is specified, the system must read this byte before processing the remainder of the block. If the system does not recognize the block, it must ignore the remainder of the block, and use the length field at offset 00 to determine the starting location of the next block.

Offset 02 – Vendor ID

This two byte little-endian (least significant byte read first) field uniquely identifies the vendor of the cable. Since Device IDs are not universally unique, but rather are unique only to the vendor, the combination of Vendor ID and Device ID are required to determine unambiguously the cable’s identity. Vendor IDs are administered initially by CERDEC. The following Vendor IDs have been assigned:

ID	Vendor
0	Prototype
1	AFRL
2	AMI Fuel Cell
3	ARO
4	CERDEC
5	Medipak
6	MicroSun
7	Protonex
8	Smart Fuel Cell
9	Ultracell
10	EFB

11	NSRDEC
12	NSWCC-Dahlgren
13	Pramacom
14	Raytheon
15	Harris
16	QinetiQ
17	USMC
18	Rockwell-Collins
19	
20	
21	

Offset 04 – Device ID

This two byte little-endian (least significant byte read first) field uniquely identifies the cable within the ID space of the vendor. Since Device IDs are not universally unique, but rather are unique only to the vendor, the combination of Vendor ID and Device ID are required to determine unambiguously the cable's identity.

It is important to note that a power manager is not required to know the parameters associated with a particular device ID in order to operate with the cable. This field is merely for unique identification.

Also note that a vendor is advised never to have two cable definitions bearing the same ID. However, two definitions that are identical but differ only in part number (for instance a battery connector that comes in a straight connector and a right angle connector) it is advised at the Device ID be the same, as it is nominally the same device being used in each case.

Offset 06 – Serial Number

This optional 16 bit integer indicates the serial number of the cable. Power managers may choose to log or taker action based upon the serial number of the cable attached. Power managers shall not modify this value. Any non-serialized cable shall use the number 0 in this field.

Offset 08 – Cable Name

This null-terminated ASCII string may be displayed by power managers or other devices, indicating to the user the intended use of the cable. Note that the maximum string length is 15 characters, since the ending null is not optional. If a string shorter than 15 characters is used, the remaining bytes of the field should be null-filled.

Valid characters include upper and lower case letters, numbers, and punctuation marks. Extended characters, control characters (LF, BS, CR, BEL, ESC, etc) or other non-printable ASCII characters are not valid.

Offset 24 – Intellicable Spec Version

The version of the Intellicable spec that this cable adheres too. Primarily used by PC-Apps when viewing cables, and for identifying cables that should be updated to enhance their functionality. When referring to this document, the "Implementation Revision" what should be placed in this field.

Offset 25 – Serial Number (Upper 16-bits)

This field is used to extend the Serial Number field by an additional 16-bit (thus creating a 32-bit capable serial number) but keeping backwards compatibility with older cables and firmware. The upper 16-bit of a 32-bit serial number are stored in this field, while the lower 16-bits are stored in the previous serial number field, just as it was before.

Offset 27 – Part Number

This null-terminated ASCII string stores the vendor specific part number of this particular cable. It can be used in a Quality Control process to verify that the information stored within the cable matches the cables design.

Offset 39 – Revision Number

This field can be used to indication the version or revision of the information in the cable. It can be used to help identify which cables may need to be updated with a new version of the software.

Offset 41 – Programmed By

This field is used to store the MAC address of the computer that programmed the cable. This allows traceability, so should a cable cause damage in the field due to faulty data it can be traced back to the location in which it was programmed.

Offset 53 – Generic Properties

This field is used to indicate if the device has any special properties that need to be taken into account. Each bit in the byte represents a different property. A device may have more than one bit set if appropriate. This field functions much like the Unique Properties field from the legacy Output block, however it only contains properties that are can be present on multiple types of devices. Properties unique to certain classes of devices will be present under those specific blocks (for instance, Unstable Sources are unique to Source devices and would never be present on a Load or Battery device).

1st bit (0x01) USB Capable

2nd bit (0x02) UART Capable

3rd bit (0x04) Paired Cable

Example:

If a device was both USB Capable and UART Capable, it would have the value 0x03 (0x01 + 0x02) entered into this field.

Explanation of bits:

USB Capable: If a device also has USB present (such as a cable that splits at the end to power a Toughbook laptop and plug into a USB port), then this bit should be selected.

UART Capable: If a device is capable of communicating over a UART, this bit should be selected. This will likely only be for communicating with other Power Manager devices, but in the future may be supported by other devices.

Paired Cable: This bit means that this cable is part of a reverse Y cable (there are 2 plugs into the power manager for one device) and has a matching pair. An example of this would be a device that needs more power than a single converter on a power manager could provide, so a cable is built to plug into two converters on the power manager to get double the power. This bit tells the power manager that two cables are linked and should be considered one entity, and both cables need to be powered at the same time. To match two cables together, they must both have this bit set and matching serial numbers.

Offset 57 – 8-bit CRC

This one byte CRC is calculated by using a simple CRC-ATM scheme with the polynomial x8 + x2 + x + 1 starting from offset 00 to the offset specified by the ID Block Size (default of 27 for this version of the specification).

Offset 58 – End Indicator

This one byte field is always set to A5h, and may be checked by the power manager to assure that the block is in fact ending.

End Block

This block indicates that no more blocks are present in the cable. When a power manager or intelligent device reads this block, it shall stop reading further.

The block is defined as follows:

Offset	Size	Values	Description	Notes
00	1 Byte	Block Dependant (fah max)	End Block size, in bytes, minus checksum and End Indicator.	Permits End block to grow, so pwr mgr can skip over unknown fields
01	1 Byte	FFh	Block Identifier	Indicates that this is the End block.
02	1 Byte	A5h	End Indicator	Permits checking that size byte was read correctly.

Offset 00 – End Block size

This byte field, an unsigned integer, indicates the total number of block bytes, minus the End Indicator. This permits the addition of fields following the Block Identifier in future versions of the specification, without breaking earlier implementations.

If the power manager reads an End Block size larger than the number of fields it knows how to decode, it must use the first fields (the one it knows the function of), and then skip the remaining fields.

Offset 01 – Block Identifier

This byte field, an unsigned integer with value FFh, indicates that this is an End block. The system must stop processing blocks upon reading this indicator. The data patterns present in any remaining memory within the Intelllicable device following this block is undefined, and should not be read nor decoded.

Offset 02 – End Indicator

This one byte field is always set to A5h, and may be checked by the power manager to assure that the block is in fact ending.

Layer 3 – Information (Legacy 7-Pin Connectors)

This block must be included in all 7-pin connectors that can be plugged into existing devices (regardless of whether or not it is specifically designed for that device). This allows all future cables to be backwards compatible with all existing gear.

Output

Each IntelliCable contains one Output block. This blocks are shown below.

If a field has a * next to its name, than it has an auxiliary meaning under certain circumstances. See the detailed description for more information.

Offset	Size	Values	Description	Notes
00	1 Byte	Block Dependant (fah max)	Output Block size, in bytes, minus checksum and End Indicator.	Permits Output block to grow, so pwr mgr can skip over unknown fields
01	1 Byte	02h	Block Identifier	Indicates that this is an Output block.
02	2 Bytes	0000-ffffh	*Nominal Voltage	Specified in millivolts, this is the nominal no-load output voltage. No nominal voltage is signified with 0h. (range is 1 to 65.535 volts)
04	2 Bytes	0000-ffffh	Max Current Supply/Discharge	Specified in milliamps, this is the current entering the power manager above which the port should disable to protect the attached equipment. No limit is signified with 0h. (range is 1 to 65.535 amps)
06	2 Bytes	0000-ffffh	Max Current Load/Charge	Specified in milliamps, this is the current exiting the power manager above which the port should disable to protect the attached equipment. No limit is signified with 0h. (range is 1 to 65.535

				amps)
08	2 Bytes	0000-ffffh	*Minimum Voltage/Discharge Disconnect Point	Specified in millivolts, this is the minimum sustainable voltage. No minimum is signified with 0h. (range is 1 to 65.535 volts)
10	2 Bytes	0000-ffffh	*Maximum Voltage/Top Charge	Specified in millivolts, this is the maximum sustainable voltage. No maximum is signified with 0h. (range is 1 to 65.535 volts)
12	1 Byte	00-ffh	Device Type	See description
13	1 Byte	00-ffh	SmBus Address	SmBus address that can be used to contact a SmBus Capable device.
14	1 Byte	00-0Ah	Default Device Priority	Priority level that should be given to this device. Default is 0 (no priority)
15	1 Byte	See Description	Unique Properties	See description
16	12 Bytes	See Description	Charge Level	See description
28	1 Byte	00-ffh	Max Discharge Temp	Maximum internal temperature in C that a battery can be discharged too. No limit is ffh
29	1 Byte (Signed)	-126 through 127 (00-ffh)	Min Charge Temp	Minimum internal temperature in C for the battery to safely accept a charge. Range is -119 - +127. No limit is -120 (or lower).
30	1 Byte (Signed)	-126 through 127 (00-ffh)	Max Charge Temp	Maximum internal temperature in C for the battery to safely accept a charge. Range is -119 - +127. No limit is -120

				(or lower).
31	2 Bytes	1-65535	*Average Power	The average power (in 10's of mWs) that the load device will draw. No average (or not applicable) is 0. See description for batteries/sources.
33	2 Bytes	1-65535	*Peak Power	The peak power (in 10's of mWs) that the load device will draw. No average (or not applicable) is 0. See description for batteries/sources.
35	1 Byte	0-255	SmBus Devices	The number of SmBus devices attached to the cable. See description for more details.
36	1 Byte	0-255	SmBus Mux Address	The base address any SmBus muxes in use. See description for more details.
37	1 Byte	0-255	SmBus Mux Offset	The necessary offset of any SmBus muxes in use. See description for more details.
38	2 Bytes	0000-ffffh	*Cable Max Charge Current	Maximum current that the physical cable can provide to a device.
40	2 Bytes	0000-ffffh	Top Charge Cutoff Current	The current at which charging of a battery should be terminated.
42	2 Bytes	0000-ffffh	*Floor Voltage	Minimum voltage a battery can be at (see description for details).
44	4 Bytes	See Description	Unique Properties 2	See Description
48	1 Byte	00-ffh	8-bit CRC	x8 + x2 + x + 1 of all Output bytes in this block up to the byte prior to this one.

49	1 Byte	A5h	End Indicator	Permits checking that size byte was read correctly.

Offset 00 – Output Block size

This byte field, an unsigned integer, indicates the total number of header bytes, minus the final checksum and Output End Indicator. This permits the addition of fields following the Maximum Voltage in future versions of the specification, without breaking earlier implementations.

If the power manager reads an Output Block size larger than the number of fields it knows how to decode, it must use the first fields (the one it knows the function of), and then skip the remaining fields, except that it must include the skipped fields in calculating its checksum.

Offset 01 – Block Identifier

This byte field, an unsigned integer with value 02h, indicates that this is an Output block. Since no specific block order is specified, the system must read this byte before processing the remainder of the block. If the system does not recognize the block, it must ignore the remainder of the block, and use the length field at offset 00 to determine the starting location of the next block.

Offset 02 – Nominal Voltage

This 16 bit unsigned integer (little-endian) represents the number of millivolts desired at the power manager connector. The range specified may be 0001 to ffffh, representing .0001 to 65.535 volts. Note that most power managers will not support this entire range. Not all devices have a nominal voltage range, and they will work equally well over their entire minimum to maximum range (such as most military batteries and equipment powered by those batteries). If there is no nominal voltage, it is signified as 0h.

Besides the Nominal Voltage, the Minimum and Maximum acceptable voltages are specified below. If the power manager is capable of supplying the nominal voltage, it should do so. If, however, the nominal voltage falls outside the power manager's output range, but the power manager can provide a power level between the minimum and maximum voltages, the power manager provides power at as near the nominal voltage it can. More details and examples are given in the Behavior section of this document.

When a cabled is marked as Tendered (see unique properties) the Nominal Voltage is used as the voltage point where the system should stop charging it. It may or may not be the same as the Maximum Voltage.

Offset 04 – Max Current Supply/Discharge

This 16 bit unsigned integer (little-endian) represents the number of milliamps of supply current entering the power manager at which it should disconnect the input to prevent damage to the attached supply. It is suggested that power managers permit surge currents

above this limit for brief periods. More details and examples are given in the Behavior section of this document.

Offset 06 – Max Current Load/Charge

This 16 bit unsigned integer (little-endian) represents the number of milliamps of load current at exiting the power manager at which it should disconnect the output to prevent damage to the attached load. It is suggested that power managers permit surge currents above this limit for brief periods. More details and examples are given in the Behavior section of this document.

Offset 08 – Minimum Voltage/Discharge Disconnect Point

Many powered devices have a range of acceptable input voltages, part of which may fall outside of a given power manager's output range. The specification of minimum and maximum voltages permits a power manager to power a device even though the device's nominal voltage falls outside the power manager's output range. For example, a particular laptop computer may have a nominal input voltage of 19.5V, with an acceptable range of 17-21V. A power manager may have an output that varies from 12-18VDC. The power manager cannot provide the 19.5V nominal needed by the device, but it can provide a very acceptable 18V instead. More details and examples are given in the Behavior section of this document.

When a cabled is marked as Tendered (see unique properties) the Minimum Voltage is used as the point in which the system should begin charging the battery.

Offset 10 – Maximum Voltage/Top Charge

Many powered devices have a range of acceptable input voltages, part of which may fall outside of a given power manager's output range. The specification of minimum and maximum voltages permits a power manager to power a device even though the device's nominal voltage falls outside the power manager's output range. For example, a particular laptop computer may have a nominal input voltage of 11.5V, with an acceptable range of 9-13.6V. A power manager may have an output that varies from 12-18VDC. The power manager cannot provide the 11.5V nominal needed by the device, but it can provide a very acceptable 12V instead. More details and examples are given in the Behavior section of this document.

When a cabled is marked as Tendered (see unique properties) the Maximum voltage is the maximum voltage that a battery can be at, and is not the top charge voltage. This value may or may not be the same as the Nominal Voltage.

Offset 12 – Device Type

The Device Type is broken up into two, four bit fields. The first four bits are used to describe the generic device type while the later four bits are used to describe a specific device type. The specific device type is often only used by Power Managers that have a display of some kind and is not a necessary field.

The generic device type bits are used to identify generic types so that the power manager knows what it can do with the attached device. Loads are described as pieces of

equipment that only consume power, such as laptops and radios. Batteries are described as pieces of equipment that can both consume power (charging) and provide power (discharging). Examples include the Li-145 and BB-2590. Sources are described as pieces of equipment that can only provide power and cannot consume it. This includes devices that attach through the scavenger input such as a solar blanket, or primary batteries (those that cannot be recharged), such as the BA-5590.

ID	Generic Device Type
00	Prototype
01	Simple Load
02	SmBus Optional Load
03	SmBus Required Load
04	Simple Battery
05	SmBus Optional Battery
06	SmBus Required Battery
07	Simple Source
08	SmBus Optional Source
09	SmBus Required Source
10	SmBus Required Power Manager
11	Power Manager
12	Undefined
13	Undefined
14	Undefined
15	Undefined

The specific device type is used to further identify the device attached the Power Manager. This field is often extra information or ‘fluff’, used for the purpose of displaying icons on a display, or to allow the user to override default priorities. It is up to the vendor as to whether or not to use this field.

ID	Specific Device Type
16	AC Adapter
32	Solar Blanket
48	Vehicle Power

64	Fuel Cell
80	Radio
96	Laptop
112	Battery
128	Fan
144	Kinetic
160	Undefined
176	Undefined
192	Undefined
208	Undefined
224	Undefined
240	Undefined

The final value of this field will be the concatenation of the generic and specific types. For instance, an SmBus Required Load that is a Laptop would have a Device Type of 99. The lowest four bits (3) is the SmBus Required Load, which all power managers must pay attention to. The highest four bits (96) means a laptop is attached. The Power Manager may or may not use this information for control algorithms, display information or other uses.

Offset 13 – SmBus Address

This field is used to declare the SmBus address, if any, that an attached device will respond too. If a non-SmBus capable device is attached, this field is 0. Note, this is the 7-bit address before bit-shifting.

If the device responds to more than a single address, this field specifies the primary address.

Offset 14 – Default Device Priority

This field is used to determine the priority of the device. These are the default settings that are used unless changed by the user. Priority only affects Sources and Loads. A higher priority for a source means that its power, if available, is consumed first. A higher priority for a load means if a power manager has to start disconnecting loads to continue running, it will disconnect the lowest priority loads first. The highest priority load in the system will be disconnected last. For both Sources and Loads, higher numbers mean higher priority, up to a limit of 0Ah (10 decimal). This field will be ignored for batteries.

A rough guide for priority assignments for loads follows:

01 – 02 Lowest priority – Entertainment and comfort devices.

03 – 04	Low – Microclimate, other devices that are not mission-critical.
05 – 06	Medium– Redundant items, battery chargers, laptop computers that have their own batteries.
07 – 08	High – Mission critical items – inter-squad radios, targeting, SA, weapons.
09 – 10	Highest – Survival – intra-squad radios, weapons, night vision.

A rough guide for priority assignments for sources follows:

01 – 05	**Non-Renewable sources**
01 – 02	Lowest - Can run the system normally in case of an emergency (Primary Batteries)
03 – 05	Low – Can be periodically refilled but has limit capacity/fuel (Fuel Cells)
06 – 10	**Renewable Sources**
06 – 08	Medium- Unlimited power, but power ultimately comes from a larger source (Ac Adapter)
09 – 10	High- Infinite power from an infinite source (Solar Blankets)

Offset 15 – Unique Properties

This byte is used to indicate if the device has any unique properties that need to be taken into account. Each bit in the byte represents a different property. A device may have more than one bit set if appropriate.

1st bit (0x01)	Unstable source
2nd bit (0x02)	Backwards current protection present
3rd bit (0x04)	USB Capable
4th bit (0x08)	Current Limited
5th bit (0x10)	Is Tendered
6th bit (0x20)	UART Capable
7th bit (0x40)	Series Mode Battery
8th bit (0x80)	Remote Starter

Example:

If a device was both an unstable source and had backwards current protection, it would have the value 0x03 (0x01 + 0x02) entered into this field.

Explanation of bits:

Unstable source: If a device is marked as an unstable source then it means that it is not always able to provide a stable amount of power. An example of this is a solar blanket. Although a 30W solar blanket may be capable of providing 30W, it may fluctuate wildly,

even over the period of a few seconds, by shadows cast on it or by cloud cover. It cannot be relied upon to provide its full capabilities.

Backwards current protection present: A device that protects itself and prevents itself from being damaged by backwards current flow will have this bit set. An example of this is the BA5590. If is it connected to a power manager, the system knows that it doesn't have to protect it if current should attempt to flow into it, it will protect itself. This is an important safety feature as not all devices have it built in. For example, if an AC Adapter were plugged into a power manager and was providing power at 15V, the adapter could be damaged if another device was hooked up that pulled the system's voltage above 15V. Current may attempt to flow into the AC Adapter, damaging it. This bit will inform the power manager that the device is incapable of protecting itself and must be protected. This field is predominately used for sources, since load's require current to run and batteries can both source and sink current.

USB Capable: If a device also has USB present (such as a cable that splits at the end to power a Toughbook laptop and plug into a USB port), then this bit should be selected.

Current Limited: If a device has the Current Limited bit set, than that means it is capable of regulating its own output to prevent too much current from being drawn. This bit will generally be set on Fuel Cells.

Is Tendered: This field is generally used by power generators (such as large fuel cell systems) rather than power managers. This bit says that this device should be tended and charged when it's voltage has dropped below the nominal voltage. Is most likely to be used by a fuel cell acting in a UPS situation.

UART Capable: If a device is capable of communicating over a UART, this bit should be selected. This will likely only be for communicating with other Power Manager devices, but in the future may be supported by other devices.

Series Mode Battery: If this cable connects the battery in series mode, the smbus commands must be interpreted in a different manner. This bit informs the Power Manager of this.

Remote Starter: This field is generally used by power generators (such as fuel cell systems) in monitoring situations. This cable bit means that the power generator should start (or stop) based upon whether or not a voltage is present (configurable). This allows it to be remotely controlled by another system.

Offset 16 – Charge Level

This field is used to describe the voltage to charge percent of a particular battery (or source, in the case of non-rechargeable batteries). The first 2 bytes are used to describe the voltage when it reaches 0%. The next 2 are used to describe the voltage at 20%, then 40%, 60%, 80% and 100%. These values are then used by the power manager to interpolate the relative charge of a device based upon its voltage. Note, these values are used only if a power manager is incapable of speaking with a particular device, either because the device is not Smbus capable, or because it has been damaged and can't speak. It is suggested that these fields be entered for any applicable device, but it is not

necessary. If no values are entered (or it's not applicable on this specific device), all fields are to be left at 0..

Below is an entry using example using a fictitious battery:

Place in cable	Value entered
1st 2 bytes (0% charge)	12000
2nd 2 bytes (20% charge)	12800
3rd 2 bytes (40% charge)	13900
4th 2 bytes (60% charge)	14500
5th 2 bytes (80% charge)	15600
6th 2 bytes (100% charge)	16300

Offset 28 – Max Discharge Temp

When batteries become too hot they can be damaged or even explode if they are discharged. This field represents the maximum temperature in C that a battery can be at and be safely discharged. Any temperature above this and the Power Manager should disable the port. If there is no limit, such as if the device is not a battery or there is no way to determine its temperature (dumb battery) then ffh should be entered.

Offset 29 – Min Charge Temp

When batteries become too cold they can be damaged or even explode if they are charged. This field represents the minimum temperature in C that a battery must be at before it can start being charged. Any temperature below this and the Power Manager should disable charging on the port. If there is no limit, such as if the device is not a battery, there is no way to determine its temperature (dumb battery) or it doesn't support charging then -127 should be entered. This is a signed 8-bit field, so the valid range is -126 through +127.

Offset 30 – Max Charge Temp

When batteries become too hot they can be damaged or even explode if they are charged. This field represents the maximum temperature in C that a battery can attain and still be safely charged. Any temperature above this and the Power Manager should disable charging on the port. If there is no limit, such as if the device is not a battery, there is no way to determine its temperature (dumb battery) or it doesn't support charging then -127 should be entered. This is a signed 8-bit field, so the valid range is -126 through +127.

Offset 31 – Average Power

This is the average power that the device will draw/provide, in 10's of milliwatts (i.e. if a radio draws 5W on average (which is 5000 mW), this field will read 500.

When referring to loads, this is the average power that the device will draw in steady state. This field is important because devices such as radios will have a very high peak current draw but will only use that while actively transmitting and will often idle at far

below that peak draw. For devices with internal batteries that can be charged (such as laptops) the average current should assume that the internal batteries are full.

This field is not applicable for the majority of battery and source devices and should be entered as 0. Only devices marked as 'unstable' should have a value entered here. This field should be used by the power manager to determine the amount of power that the device can reasonably be expected to provide. This value is often far lower than the peak the device is capable of.

Offset 33 – Peak Power

This is the peak power that a device is capable of drawing/provide, in 10's of milliwatts (i.e. if a radio draws 30W a peak (which is 30000 mW), this field will read 3000.

When referring to loads, this is the maximum power that will ever be required to power them. In the case of radios, this is often only when the transmit button has been keyed. For laptops (and other devices with internal batteries that can be charged), this field includes that extra power draw.

This field is not applicable for the majority of battery and source devices and should be entered as 0. However, certain devices may have a maximum power rating that is independent of the amount of current they can provide. Many converters function in this manner. If the device has an independent power limit, then enter that value into this field.

Offset 35 – Smbus Devices

This field is the number of smbus devices attached to this cable. For any smbus capable devices, a value of zero or one means there is only one device attached. Any value above one is the number of devices attached. The comes into play in the case of the BB-2590. There are two halves to the battery, each with their own Smbus interface. There may, in the future, be other devices that have more than two smbus interfaces on them.

Offset 36 – Smbus Mux Address

If a device has more than one smbus interface to it, such as the BB-2590, and there is a way to communicate with both sides, then there is likely a mux in between that allows the Power Manager to communicate with both sides. This field contains the address of the mux. Note, this is the 7-bit address before bit-shifting.

Offset 37 – Smbus Mux Offset

Many smbus muxes have an offset that must be logical or'd with any channel switches. If such an offset exists, it is placed in this field.

Offset 38 – Max Cable Charge Current

This field is only used for Smbus capable batteries. Cables definitions have the default values for charging batteries, but a battery can request a different amount via Smbus. This field is used as an absolute maximum that this cable is capable of providing for charging a device. This field is optional.

An example would be with a BB-2590. Some cables have charge circuitry in the cups that prevent too much current from flowing into one side in the case of imbalanced cells. If a new version of the 2590 were to come out that could accept greater amounts of current, it would overwhelm the circuitry in existing cables. This field prevents that by providing the system with knowledge of what the maximum current this cable can handle is. Since not all cables have limiting circuitry, this field is optional. It applies only to current entering the battery, not leaving it.

Offset 40 – Top Charge Cutoff Current

Different batteries have different points at which they are considered to be completely charged. This field is used to designated the current limit at which point the battery is considered fully charged. When the current flowing into the battery is below this point (and is not being inhibited for other reasons) the power manager should stop charging them and mark them as full. All power managers should implement a default charge disconnect point, as older cables may not contain this field.

Offset 42 – Floor Voltage

This field is only used when the Tendered unique property is set. This field is used as the minimum safety voltage of the battery. If the battery voltage is below this point it should not be charged as it can be potentially unsafe.

Offset 44 – Unique Properties 2

This byte is used to indicate if the device has any unique properties that need to be taken into account and is a continuation of the bits in “Offset 15 Unique Properties”. Each bit in the byte represents a different property. A device may have more than one bit set if appropriate and can be used in addition to the bits from “Offset 15 Unique Properties”

1st bit (0x00000001) Smbus Master

2nd bit (0x00000002) NiMH/NiCAD

3rd bit (0x00000004) Charge at Nominal

4th bit (0x00000008) Product Specific 1

5th bit (0x00000010) Product Specific 2

Explanation of bits:

Smbus Master: The checking of this bit means that this particular device is an smbus master and the power manager or fuel cell should go into smbus slave mode (if it’s able too) and be prepared to respond to queries from this device. The smbus address field (Offset 13) can be used to tell the power manager what address to configure itself for.

NiMH/NiCAD: The checking of this bit means that this particular battery is not a Lithium-ion but is a NiCAD or a NiMH and should be charged accordingly.

Charge at Nominal: Batteries are normally charged according to their Maximum Voltage field. Selecting this bit means that they will instead be charged to their Nominal Voltage field. It is useful for devices such as Car Battery chargers where the internal voltage can reach as high as 14.4V, but should not normally be charged past 13.8V.

Product Specific 1: The function of this bit will vary on a per product basis. Please refer to your products documentation for details on the specific function of this bit.

Product Specific 2: The function of this bit will vary on a per product basis. Please refer to your products documentation for details on the specific function of this bit.

Offset 48 – 8-bit CRC

This one byte CRC is calculated by using a simple CRC-ATM scheme with the polynomial x8 + x2 + x + 1 starting from offset 00 to the offset specified by the Output Block Size (default of 13 for this version of the specification).

Offset 49 – End Indicator

This one byte field is always set to A5h, and may be checked by the power manager to assure that the block is in fact ending.

Cable Usage

A cable may optionally include a Cable Usage data block. Similarly, a power manager may optionally set the values in this block. If a cable does not include a Cable Usage block, the power manager should ignore this functionality. If the power manager finds a Cable Usage block, it may update one or more of the applicable values.

Note that this block is not CRC protected, saving an intelligent device the need to update a CRC each time a value is incremented.

The block is defined as follows:

Offset	Size	Values	Description	Notes
00	1 Byte	Block Dependant (fah max)	Cable Usage Block size, in bytes, minus checksum and End Indicator.	Permits Cable Usage block to grow, so pwr mgr can skip over unknown fields
01	1 Byte	03h	Block Identifier	Indicates that this is a Cable Usage block.
02	2 Bytes	0000-ffffh	Insertions	This value is incremented by the power manager on each cable insertion.

04	2 Bytes	0000-ffffh	Use Hours	This value is incremented once per hour of cable usage
06	2 Bytes	0000-ffffh	Protection Counter	This value is incremented once each time the power manager’s port protection is triggered with this cable attached.
08	1 Byte	A5h	End Indicator	Permits checking that size byte was read correctly.

Offset 00 – Usage Block size

This byte field, an unsigned integer, indicates the total number of header bytes, minus the final checksum and Usage End Indicator. This permits the addition of fields following the Protection Counter in future versions of the specification, without breaking earlier implementations.

If the power manager reads an Usage Block size larger than the number of fields it knows how to decode, it must use the first fields (the one it knows the function of), and then skip the remaining fields, except that it must include the skipped fields in calculating its checksum.

Offset 01 – Block Identifier

This byte field, an unsigned integer with value 03h, indicates that this is an Cable Usage block. Since no specific block order is specified, the system must read this byte before processing the remainder of the block. If the system does not recognize the block, it must ignore the remainder of the block, and use the length field at offset 00 to determine the starting location of the next block.

Offset 02 – Insertions

This 16 bit unsigned integer (little-endian) represents the number of times the cable has been inserted into a power manager or other intelligent device. When an intelligent device detects that this cable has been inserted, it may read this value, increment it, and write the incremented value to the same location. If the value is at its maximum value (FFFFh), the device shall not increment it to zero, but shall leave it at its maximum value.

Note that insertions into non-intelligent devices, or into devices which are not operational will not result in an incremented value, and as such this is only a rough estimate of the cable’s usage.

Offset 04 – Use Hours

This 16 bit unsigned integer (little-endian) represents the number of hours the cable has been in operation with a power manager or other intelligent device. When an intelligent device detects that this cable has been inserted, it may read this value, and after an hour of operation increment it, and write the incremented value to the same location. If the value is at its maximum value (FFFFh), the device shall not increment it to zero, but shall leave it at its maximum value.

The device should not write a value to the cable for period of usage less than one hour. Note that usage with non-intelligent devices will not result in an incremented value, and as such this is only a rough estimate of the cable's usage.

Offset 06 – Protection Counter

This 16 bit unsigned integer (little-endian) represents the number of times the cable has caused a protection fault by a power manager or other intelligent device. When an intelligent device detects that this cable has been inserted, it may read this value, and write an incremented value to the same location when and if a protection fault occurs. If the value is at its maximum value (FFFFh), the device shall not increment it to zero, but shall leave it at its maximum value.

Intelligent devices may indicate to the user that premature failure is likely should a large number of faults be generated by the cable. Note that usage with non-intelligent devices will not result in an incremented value, and as such this is only a rough estimate of the cable's usage.

Offset 08 – End Indicator

This one byte field is always set to A5h, and may be checked by the power manager to assure that the block is in fact ending.

Layer 3 – Information (New Formats)

The information contained in Layer 3 Legacy 7-Pin Connectors has served well for many years. However, it has grown in size considerably, has fields that are too small for their desired effect and contains many fields that are only used on a small subset of devices which can make it confusing to create a definition for a new device. Additionally, it is tailored to having exactly one device for each cable which does not make it easily scalable.

A new format for cable definitions exist below. Many of the fields are identical to the ones mentioned above but they are organized far more intelligently. Instead of having one block that contains all output data possible for every attached device, there is instead a block for each *type* of device that can be attached. Furthermore, it is possible for each block to exist more than once (with the exception of the Device ID block). That means that if, for instance, a Y cable is created that connects to two separate Smbus capable devices with different addresses, the Smbus Data block would be included twice, once for each device to be talked too. The blocks mentioned ahead are replacing the Output Block, the Device ID block will continue to be used.

Backwards Compatibility

To maintain backwards compatibility, these data blocks have been given different ID's than the previously described blocks. Furthermore, in cables that are capable of being plugged into legacy 7-pin connector gear, it is required that the legacy Output Block be programmed into the cable as well, starting immediately after the Device ID block. This allows legacy equipment to continue to function exactly as before, but new gear can skip over the legacy block and is capable of taking advantage of the advanced features of the new blocks. New gear should read the Device ID block and if version 26 or higher is present, they should look for new blocks after the Output Block.

Load Data

The Load Data information block is used to describe load devices. Load devices are defined as anything that require power to run. This includes radios, laptops, inverters, USB Chargers, etc.

Offset	Size	Values	Description	Notes
00	1 Byte	Block Dependant (fah max)	Load Data Block size, in bytes, minus checksum and End Indicator.	Permits ID block to grow, so pwr mgr can skip over unknown fields
01	1 Byte	04h	Block Identifier	Indicates that this is a Load Data block.
02	1 Byte	0-ffh	Unique Node Id	Identifies this block, see description
03	1 Byte	00-f0	Device Icon	Special icons that should be displayed (see description)
04	1 Byte	00-0a	Device Priority	How important this device is (see description)
05	4 Bytes	00h-ffffffffh	Minimum Voltage	Specified in millivolts, this is the minimum sustainable voltage. No minimum is signified with 0h.
9	4 Bytes	00h-ffffffffh	Nominal Voltage	Preferred output voltage of device.
13	4 Bytes	00h-ffffffffh	Maximum Voltage	Specified in millivolts, this is the maximum sustainable voltage.
17	4 Bytes	00h-ffffffffh	Maximum Current	Specified in milliamps, this is the current exiting the power manager above which the port should disable to protect the attached equipment.
21	4 Bytes	00h-ffffffffh	Average Power	The average power that the load device will draw.

25	4 Bytes	00h-ffffffffh	Peak Power	The peak power that the load device will draw.
29	4 bytes	See Description	Unique Properties	See description
33	1 Byte	00-ffh	8-bit CRC	x8 + x2 + x + 1 of all ID bytes up to the byte prior to this one.
34	1 Byte	A5h	End Indicator	Permits checking that the size byte was read correctly.

Offset 00 – Load Data Block size

This byte field, an unsigned integer, indicates the total number of header bytes, minus the final checksum and Load Data End Indicator. This permits the addition of new fields without breaking earlier implementations.

If the power manager reads a Load Data Block size larger than the number of fields it knows how to decode, it must use the first fields (the one it knows the function of), and then skip the remaining fields, except that it must include the skipped fields in calculating its checksum.

Offset 01 – Block Identifier

This byte field, an unsigned integer with value 04h, indicates that this is a Load Data block. Since no specific block order is specified, the system must read this byte before processing the remainder of the block. If the system does not recognize the block, it must ignore the remainder of the block, and use the length field at offset 00 to determine the starting location of the next block.

Offset 02 – Unique Node Identifier

This bye field is used by the power manager to make logical connections between blocks in the cable and physical connections between blocks and circuits. For example, if a single port on a power manager has two logical circuits, the power manager will use the Unique Node Identifier to determine the order of attached devices. Furthermore, the Unique Node is used by the Smbus Block to associate its data with a specific block. For example:

A Power Manager has one physical port that has three separate electrical connections inside of it. The first connection is designed as an output, the second is designed as an input, the third is defined as an output. The cable associated with that port would have three blocks, a Load Block, a Source Block and another Lock Block. The first load block would have a Unique Identifier of 0, the source block would have a 1 and the second load block would have a 2. Additionally, if there were smbus data associated with the source block, it would use 1 as its Associated Node Block.

This allows the blocks to be put into the cable in any order but the power manager still knows the logical order in which to connect them.

Offset 03 – Device Icon

This field can be used to indicate that a certain icon should be displayed to the user. It is an optional field that has no effect on system operation and is purely information for the user. If it is unused it should be set as 0, which will allow the power manager to display an image of its own choosing (or none at all). To make it easier for new gear to support both old cables and new cables, the values will match those found in the legacy definition. The legacy definitions previously stored this information in the upper 4 bits of the Device Type in the Output block, so the values will seem a bit odd:

ID	Device Icon
16	AC Adapter
32	Solar Blanket
48	Vehicle Power
64	Fuel Cell
80	Radio
96	Laptop
112	Battery
128	Fan

Values above 240 are reserved for internal Power Manager use, so it can easily set things to display warnings, errors or as default images if none is specified here.

Offset 04 – Default Device Priority

This field is used to determine the priority of the device. These are the default settings that are used unless changed by the user.

For loads, it implies how important that device is. A higher priority for a load means if a power manager has to start disconnecting loads to continue running, it will disconnect the lowest priority loads first. The highest priority load in the system will be disconnected last. It is suggested that a priority 10 load be marked as mission critical by the power manager and only disconnect it under extreme circumstances.

A rough guide for priority assignments for loads follows:

01 – 02 Lowest priority – Entertainment and comfort devices.

03 – 04 Low – Microclimate, other devices that are not mission-critical.

05 – 06 Medium– Redundant items, battery chargers, laptop computers that have their own batteries.

07 – 08	High – Mission critical items – inter-squad radios, targeting, SA, weapons.
09 – 10	Highest – Survival – intra-squad radios, weapons, night vision.

Offset 05 – Minimum Voltage

Many powered devices have a range of acceptable input voltages, part of which may fall outside of a given power manager's output range. The specification of a minimum and maximum voltage informs the power manager what range the device is able to accept without being damaged. If the minimum or maximum voltages are exceeded, the power manager should disconnect the device to protect it.

Offset 09 – Nominal Voltage

This field represents the number of millivolts desired at the power manager connector. Not all devices will have a nominal voltage range and they will work equally well over their entire minimum and maximum range.

If the power manager is capable of supplying a device with its nominal voltage, it should do so. If, however, the nominal voltage falls outside the power manager's output range, but the power manager can provide a power level between the minimum and maximum voltages, the power manager provides power at as near the nominal voltage it can.

Offset 13 – Maximum Voltage

Many powered devices have a range of acceptable input voltages, part of which may fall outside of a given power manager's output range. The specification of a minimum and maximum voltage informs the power manager what range the device is able to accept without being damaged. If the minimum or maximum voltages are exceeded, the power manager should disconnect the device to protect it.

Offset 17 – Maximum Current

This field represents the number of milliamps of load current exiting the power manager at which it should disconnect the output to prevent damage to the attached load. It is suggested that power managers permit surge currents above this limit for brief periods to allow for phenomena such as startup inrush.

Offset 21 – Average Power

This is the average power that the device will draw in milliwatts. Note, unlike the Average Power field in the legacy Output Block, this field is NOT in 10's of milliwatts, it is in direct milliwatts. Therefore a value of 10,000 would be 10W, whereas it would be 100W in the legacy Output block.

This field is the average power that the device will draw in steady state. It is important because devices such as radios will have a very high peak current draw but will only use that while actively transmitting and will often idle at far below that peak draw. For devices with internal batteries that can be charged (such as laptops) the average current should assume that the internal batteries are full.

Offset 25 – Peak Power

This is the peak power that a device is capable of drawing in milliwatts. Note, unlike the Peak Power field in the legacy Output Block, this field is NOT in 10's of milliwatts. Therefore a value of 10,000 would be 10W, whereas it would be 100W in the legacy Output block.

This field is the maximum power that will ever be required to power a device. In the case of radios, this is often only when the transmit button has been keyed. For laptops (and other devices with internal batteries that can be charged), this field includes that extra power draw.

Offset 29 – Unique Properties

This byte is used to indicate if the load has any unique properties that need to be taken into account. Each bit in the byte represents a different property. A device may have more than one bit set if appropriate.

1st bit (0x01) High Inrush Current

Explanation of bits:

High Inrush Current: This bit informs the power manager that it can expect a large surge of current when first powering on this device. As such, it may device to not power on any additional devices (especially other devices with this bit set) at the same time it powers this one on. Other devices may be turned on as normal once the inrush has passed.

Offset 33 – 8-bit CRC

This one byte CRC is calculated by using a simple CRC-ATM scheme with the polynomial x8 + x2 + x + 1 starting from offset 00 to the offset specified by the Load Data Block Size.

Offset 34 – End Indicator

This one byte field is always set to A5h, and may be checked by the power manager to assure that the block is in fact ending.

Source Data

The Source Data information block is used to describe source devices. Source devices are defined as anything that is capable of generating power for other devices to use. This includes (solar blankets, AC Adapters, Primary Batteries, etc.

Offset	Size	Values	Description	Notes
00	1 Byte	Block Dependant (fah max)	Source Data Block size, in bytes, minus checksum and End Indicator.	Permits ID block to grow, so pwr mgr can skip over unknown fields
01	1 Byte	05h	Block Identifier	Indicates that this is a Source Data block.
02	1 Byte	0-ffh	Unique Node Id	Identifies this block, see description
03	1 Byte	00-f0	Device Icon	Special icons that should be displayed (see description)
04	1 Byte	00-0a	Device Priority	How important this device is (see description)
05	4 Bytes	00h-ffffffffh	Minimum Voltage	Specified in millivolts, this is the minimum sustainable voltage. No minimum is signified with 0h.
09	4 Bytes	00h-ffffffffh	Maximum Voltage	Specified in millivolts, this is the maximum sustainable voltage.
13	4 Bytes	00h-ffffffffh	Maximum Current	Specified in milliamps, this is the current entering the power manager above which the port should disable to protect the attached equipment.
17	4 Bytes	00h-ffffffffh	Average Power	The average power that the load device will draw.
21	4 Bytes	00h-	Peak Power	The peak power that the

		ffffffffh		load device will draw.
25	2 Bytes	00h-ffffffffh	Maximum Ramp Rate	Specified in milliamps, this is the maximum rate at which current can be drawn (see description).
27	16 Bytes	See Description	Charge Level	See description
43	4 bytes	See Description	Unique Properties	See description
47	1 Byte	00-ffh	8-bit CRC	x8 + x2 + x + 1 of all ID bytes up to the byte prior to this one.
48	1 Byte	A5h	End Indicator	Permits checking that the size byte was read correctly.

Offset 00 – Source Data Block size

This byte field, an unsigned integer, indicates the total number of header bytes, minus the final checksum and Source Data End Indicator. This permits the addition of new fields without breaking earlier implementations.

If the power manager reads a Source Data Block size larger than the number of fields it knows how to decode, it must use the first fields (the one it knows the function of), and then skip the remaining fields, except that it must include the skipped fields in calculating its checksum.

Offset 01 – Block Identifier

This byte field, an unsigned integer with value 05h, indicates that this is a Source Data block. Since no specific block order is specified, the system must read this byte before processing the remainder of the block. If the system does not recognize the block, it must ignore the remainder of the block, and use the length field at offset 00 to determine the starting location of the next block.

Offset 02 – Unique Node Identifier

This bye field is used by the power manager to make logical connections between blocks in the cable and physical connections between blocks and circuits. For example, if a single port on a power manager has two logical circuits, the power manager will use the Unique Node Identifier to determine the order of attached devices. Furthermore, the Unique Node is used by the Smbus Block to associate its data with a specific block. For example:

A Power Manager has one physical port that has three separate electrical connections inside of it. The first connection is designed as an output, the second is designed as an

input, the third is defined as an output. The cable associated with that port would have three blocks, a Load Block, a Source Block and another Lock Block. The first load block would have a Unique Identifier of 0, the source block would have a 1 and the second load block would have a 2. Additionally, if there were smbus data associated with the source block, it would use 1 as its Associated Node Block.

This allows the blocks to be put into the cable in any order but the power manager still knows the logical order in which to connect them.

Offset 03 – Device Icon

This field can be used to indicate that a certain icon should be displayed to the user. It is an optional field that has no effect on system operation and is purely information for the user. If it is unused it should be set as 0, which will allow the power manager to display an image of its own choosing (or none at all). To make it easier for new gear to support both old cables and new cables, the values will match those found in the legacy definition. The legacy definitions previously stored this information in the upper 4 bits of the Device Type in the Output block, so the values will seem a bit odd:

ID	**Device Icon**
16	AC Adapter
32	Solar Blanket
48	Vehicle Power
64	Fuel Cell
80	Radio
96	Laptop
112	Battery
128	Fan

Values above 240 are reserved for internal Power Manager use, so it can easily set things to display warnings, errors or as default images if none is specified here.

Offset 04 – Default Device Priority

This field is used to determine the priority of the device. These are the default settings that are used unless changed by the user.

Priorities affect sources differently than loads. For sources, a higher number implies that the device has less of an energy cost. For example, a solar blanket essentially has infinite power as you can’t use up all of the sun whereas a fuel cell can run out of fuel and thus will be of lower priority. It is up to the power manager on how to use this. Some will factor the priority into account and always consume the highest priority while others may

factor in available power and will always choose the one that allows them to power the most gear.

A rough guide for priority assignments for sources follows:

01 – 05	**Non-Renewable sources**
01 – 02	Lowest - Can run the system normally in case of an emergency (Primary Batteries)
03 – 05	Low – Can be periodically refilled but has limit capacity/fuel (Fuel Cells)
06 – 10	**Renewable Sources**
06 – 08	Medium- Unlimited power, but power ultimately comes from a larger source (Ac Adapter)
09 – 10	High- Infinite power from an infinite source (Solar Blankets)

Offset 05 – Minimum Voltage

This is the minimum voltage that this device is capable of producing. Should the voltage drop below that point the power manager can assume that it is not present or is incapable of providing power.

Offset 09 – Maximum Voltage

This is the maximum voltage that this device is capable of producing. If the device is outputting higher than this value it may be damaged. Additionally the power manager can use this field to protect itself as not all power managers may be able to accept the full voltage range of all devices.

Offset 13 – Maximum Current

This field represents the number of milliamps that the device is capable of providing. At no point should the power manager attempt to draw more power than this from the device.

Offset 17 – Average Power

This is the average power that the device will provide in milliwatts. Note, unlike the Average Power field in the legacy Output Block, this field is NOT in 10's of milliwatts, it is in direct milliwatts. Therefore a value of 10,000 would be 10W, whereas it would be 100W in the legacy Output block.

This field is not applicable for the majority of source devices and should be entered as 0. Only devices marked as 'unstable' are likely to have a value entered here. This field should be used by the power manager to determine the amount of power that the device can reasonably be expected to provide. This value is often far lower than the peak the device is capable of.

Offset 21 – Peak Power

This is the peak power that a device is capable of providing in milliwatts. Note, unlike the Peak Power field in the legacy Output Block, this field is NOT in 10's of milliwatts. Therefore a value of 10,000 would be 10W, whereas it would be 100W in the legacy Output block.

This field is not applicable for the majority of source devices and should be entered as 0. However, certain devices may have a maximum power rating that is independent of the amount of current they can provide. Many converters function in this manner. If the device has an independent power limit, then enter that value into this field.

Offset 25 – Maximum Ramp Rate

Some devices are incapable of going from zero power to maximum power instantly and must instead be stepped up slowly. This field represents the maximum step size in milliamps that that the power manager must adhere to when attempting to pull power from this device. This is not applicable for most devices and should be entered as 0.

Offset 27 – Charge Level

This field is used to describe the voltage to charge percent of a particular primary battery. The first 4 bytes are used to describe the voltage when it reaches 20%. The next 4 are used to describe the voltage at 40%, then 60% and lastly 80%. The minimum voltage should be used for 0% and the maximum voltage should be used as 100%.

These values are then used by the power manager to interpolate the relative charge of a device based upon its voltage. Note, these values are used only if a power manager is incapable of speaking with a particular device, either because the device is not Smbus capable, or because it has been damaged and can't speak. It is suggested that these fields be entered for any applicable device, but it is not necessary. If no values are entered (or it's not applicable on this specific device), all fields are to be left at 0.

Below is an entry using example using a fictitious primary battery whose minimum voltage is 12,000mV and maximum is 16,300mV.

Place in cable	Value entered
1st 4 bytes (20% charge)	12800
2nd 4 bytes (40% charge)	13900
3rd 4 bytes (60% charge)	14500
4th 4 bytes (80% charge)	15600

Offset 43 – Unique Properties

This byte is used to indicate if the source has any unique properties that need to be taken into account. Each bit in the byte represents a different property. A device may have more than one bit set if appropriate.

1st bit (0x01) Unstable source

2nd bit (0x02) Backwards current protection present

3rd bit (0x04) Current Limited

4th bit (0x08) Remote Starter

Example:

If a device was both an unstable source and had backwards current protection, it would have the value 0x03 (0x01 + 0x02) entered into this field.

Explanation of bits:

Unstable source: If a device is marked as an unstable source then it means that it is not always able to provide a stable amount of power. An example of this is a solar blanket. Although a 30W solar blanket may be capable of providing 30W, it may fluctuate wildly, even over the period of a few seconds, by shadows cast on it or by cloud cover. It cannot be relied upon to provide its full capabilities.

Backwards current protection present: A device that protects itself and prevents itself from being damaged by backwards current flow will have this bit set. An example of this is the BA5590. If is it connected to a power manager, the system knows that it doesn't have to protect it if current should attempt to flow into it, it will protect itself. This is an important safety feature as not all devices have it built in. For example, if an AC Adapter were plugged into a power manager and was providing power at 15V, the adapter could be damaged if another device was hooked up that pulled the system's voltage above 15V. Current may attempt to flow into the AC Adapter, damaging it.

Current Limited: If a device has the Current Limited bit set, than that means it is capable of regulating its own output to prevent too much current from being drawn. This bit will generally be set on Fuel Cells.

Remote Starter: This field is generally used by power generators (such as fuel cell systems) in monitoring situations. This cable bit means that the power generator should start (or stop) based upon whether or not a voltage is present (based upon minimum voltage). This allows it to be remotely controlled by another system.

Offset 47 – 8-bit CRC

This one byte CRC is calculated by using a simple CRC-ATM scheme with the polynomial x8 + x2 + x + 1 starting from offset 00 to the offset specified by the Source Data Block Size.

Offset 48 – End Indicator

This one byte field is always set to A5h, and may be checked by the power manager to assure that the block is in fact ending.

Battery Data

The Battery Data information block is used to describe battery devices. A battery is defined as anything that can both provide power and sink power. This includes all forms of rechargeable batteries such as (BB-2590, Li-/80145, Conformal, etc.

Offset	Size	Values	Description	Notes
00	1 Byte	Block Dependant (fah max)	Source Data Block size, in bytes, minus checksum and End Indicator.	Permits ID block to grow, so pwr mgr can skip over unknown fields
01	1 Byte	06h	Block Identifier	Indicates that this is a Source Data block.
02	1 Byte	0-ffh	Unique Node Id	Identifies this block, see description
03	1 Byte	00-f0	Device Icon	Special icons that should be displayed (see description)
04	1 Byte	00-0a	Device Priority	How important this device is (see description)
05	4 Bytes	00h-ffffffffh	Minimum Voltage	Specified in millivolts, this is the minimum sustainable voltage. No minimum is signified with 0h.
09	4 Bytes	00h-ffffffffh	Maximum Voltage	Specified in millivolts, this is the maximum sustainable voltage.
13	4 Bytes	00h-ffffffffh	Maximum Discharge Current	Specified in milliamps, this is the current entering the power manager above which the port should disable to protect the attached equipment.
17	4 Bytes	00h-ffffffffh	Maximum Charge Current	Specified in milliamps, this is the current exiting the power manager above which the port should disable to protect the

				attached equipment.
21	4 Bytes	0000-ffffffffh	Maximum Cable Charge Current	Maximum current that the physical cable can provide to a device.
25	2 Bytes	0000-ffffh	Top Charge Cutoff Current	The current at which charging of a battery should be terminated.
27	4 Bytes	0000-ffffffffh	Floor Voltage	Minimum voltage a battery can be at (see description for details).
31	16 Bytes	See Description	Charge Level	See description
47	1 Byte	0-ffh	Battery Chemistry	See Description
48	2 Bytes	0-ffffh	ESR Value	Equivalent Series Resistance of the battery. See description
50	4 bytes	See Description	Unique Properties	See description
54	1 Byte	00-ffh	8-bit CRC	x8 + x2 + x + 1 of all ID bytes up to the byte prior to this one.
55	1 Byte	A5h	End Indicator	Permits checking that the size byte was read correctly.

Offset 00 – Battery Data Block size

This byte field, an unsigned integer, indicates the total number of header bytes, minus the final checksum and Battery Data End Indicator. This permits the addition of new fields without breaking earlier implementations.

If the power manager reads a Battery Data Block size larger than the number of fields it knows how to decode, it must use the first fields (the one it knows the function of), and then skip the remaining fields, except that it must include the skipped fields in calculating its checksum.

Offset 01 – Block Identifier

This byte field, an unsigned integer with value 06h, indicates that this is a Battery Data block. Since no specific block order is specified, the system must read this byte before processing the remainder of the block. If the system does not recognize the block, it must ignore the remainder of the block, and use the length field at offset 00 to determine the starting location of the next block.

Offset 02 – Unique Node Identifier

This bye field is used by the power manager to make logical connections between blocks in the cable and physical connections between blocks and circuits. For example, if a single port on a power manager has two logical circuits, the power manager will use the Unique Node Identifier to determine the order of attached devices. Furthermore, the Unique Node is used by the Smbus Block to associate its data with a specific block. For example:

A Power Manager has one physical port that has three separate electrical connections inside of it. The first connection is designed as an output, the second is designed as an input, the third is defined as an output. The cable associated with that port would have three blocks, a Load Block, a Source Block and another Lock Block. The first load block would have a Unique Identifier of 0, the source block would have a 1 and the second load block would have a 2. Additionally, if there were smbus data associated with the source block, it would use 1 as its Associated Node Block.

This allows the blocks to be put into the cable in any order but the power manager still knows the logical order in which to connect them.

Offset 03 – Device Icon

This field can be used to indicate that a certain icon should be displayed to the user. It is an optional field that has no effect on system operation and is purely information for the user. If it is unused it should be set as 0, which will allow the power manager to display an image of its own choosing (or none at all). To make it easier for new gear to support both old cables and new cables, the values will match those found in the legacy definition. The legacy definitions previously stored this information in the upper 4 bits of the Device Type in the Output block, so the values will seem a bit odd:

ID	**Device Icon**
16	AC Adapter
32	Solar Blanket
48	Vehicle Power
64	Fuel Cell
80	Radio
96	Laptop
112	Battery
128	Fan

Values above 240 are reserved for internal Power Manager use, so it can easily set things to display warnings, errors or as default images if none is specified here.

Offset 04 – Default Device Priority

This field is used to determine the priority of the device. These are the default settings that are used unless changed by the user.

Priorities affect batteries differently than loads or sources. For batteries, the priority suggests how important the device is, with the highest level priority being drained last and charged first. However, like sources this is up to individual power manager implementation.

Offset 05 – Minimum Voltage

This is the minimum voltage that this battery is capable of producing. Should the voltage drop below that point the power manager can assume that it is not present or is incapable of providing power.

Offset 09 – Maximum Voltage

This is the maximum voltage that this battery is capable of producing. If the battery is outputting higher than this value it may be damaged. Additionally the power manager can use this field to protect itself as not all power managers may be able to accept the full voltage range of all battery.

When charging a battery, the maximum voltage is to be used as its top charge voltage point. This point can be adjusted by Smbus communication.

Offset 13 – Maximum Discharge Current

This field represents the number of milliamps that the battery is capable of providing. At no point should the power manager attempt to draw more power than this from the battery.

Offset 17 – Maximum Charge Current

This field represents the number of milliamps that the battery is capable of accepting when charging. At no point should the power manager attempt to charge a battery at a right higher than this value unless directed to by smbus communication.

Offset 21 – Maximum Cable Charge Current

This field is only used for Smbus capable batteries. Cables definitions have the default values for charging batteries, but a battery can request a different amount via Smbus. This field is used as an absolute maximum that this cable is capable of providing for charging a device. This field is optional.

An example would be with a BB-2590. Some cables have charge circuitry in the cups that prevent too much current from flowing into one side in the case of imbalanced cells. If a new version of the 2590 were to come out that could accept greater amounts of current, it would overwhelm the circuitry in existing cables. This field prevents that by providing the system with knowledge of what the maximum current this cable can handle is. Since not all cables have limiting circuitry, this field is optional. It applies only to current entering the battery, not leaving it.

Offset 25 – Top Charge Cutoff Current

Different batteries have different points at which they are considered to be completely charged. This field is used to designate the current limit at which point the battery is considered fully charged. When the current flowing into the battery is below this point (and is not being inhibited for other reasons) the power manager should stop charging it and mark it as full. All power managers should implement a default charge disconnect point, as this field is optional.

Offset 27 – Floor Voltage

This field is used as the minimum safety voltage of the battery. If the battery voltage is below this point it should not be charged as it can be potentially unsafe. This is likely only going to be used with Lead Acid batteries (see Battery Chemistry below).

Offset 31 – Charge Level

This field is used to describe the voltage to charge percent of a particular battery. The first 4 bytes are used to describe the voltage when it reaches 20%. The next 4 are used to describe the voltage at 40%, then 60% and lastly 80%. The minimum voltage should be used for 0% and the maximum voltage should be used as 100%.

These values are then used by the power manager to interpolate the relative charge of a device based upon its voltage. Note, these values are used only if a power manager is incapable of speaking with a particular device, either because the device is not Smbus capable, or because it has been damaged and can’t speak. It is suggested that these fields be entered for any applicable device, but it is not necessary. If no values are entered (or it’s not applicable on this specific device), all fields are to be left at 0.

Below is an entry using example using a fictitious battery whose minimum voltage is 12,000mV and maximum is 16,300mV.

Place in cable	Value entered
1^{st} 4 bytes (20% charge)	12800
2^{nd} 4 bytes (40% charge)	13900
3^{rd} 4 bytes (60% charge)	14500
4^{th} 4 bytes (80% charge)	15600

Offset 47 – Battery Chemistry

This field is used to inform the power manager the chemistry of the attached battery as different chemistry react differently to charging and dischargning.

The defined values are:

0- Lithium.

1- Nickel Metal Hydride (NiMH)

2- Nickel Cadmium (NiCAD)

3- Lead Acid: AGM

4- Lead Acid: Wet Cell (Flooded)

5- Lead Acid: Gel Cell

6- Multi-Chemistry

A value of 0, Lithium, should be used for all class of Lithium batteries, including Lithium-Ion and Lithium-Polymer. These all function much the same from the power manager's point of view and do not have to be differentiated.

If the value of 6, Multi-Chemistry, is chosen then the power manager must determine the type of chemistry through some means. An example of this is a universe battery cup that fits on both a BB-2590 and a BB-390. The 2590 is Lithium-Ion but the 390 is NiMH, which have incompatible charging schemes.

Offset 48 – ESR Value

This field is the Equivalent Series Resistance of the battery. It is used to help determine the true voltage of a battery, since the voltage will float when it is being charged and it will sink when it is being discharged. It can be determined by monitoring the voltage of the battery and discharging one amp of current out of it. The number of millivolts that the voltage drops is the value that should be entered into this field.

This is an optional field that can be used in conjunction with the Charge Level field to help determine the state of charge of a battery if no smbus data is available. Many battery manufacturers do not publish the ESR values of their batteries so it can usually only be determined by taking measurements in the lab while writing the definition.

Offset 50 – Unique Properties

This byte is used to indicate if the battery has any unique properties that need to be taken into account. Each bit in the byte represents a different property. A device may have more than one bit set if appropriate.

1st bit (0x01) Is Tendered

2nd bit (0x02) Series Mode Battery

Example:

If a device was both an tendered battery was in series mode, it would have the value 0x03 (0x01 + 0x02) entered into this field.

Explanation of bits:

Is Tendered: This field informs the power manager that this battery should always be kept charged and should only be used to run the power manager if no other batteries are available.

Series Mode Battery: If this cable connects the battery in series mode, the smbus commands must be interpreted in a different manner. This bit informs the Power Manager of this.

Offset 54 – 8-bit CRC

This one byte CRC is calculated by using a simple CRC-ATM scheme with the polynomial x8 + x2 + x + 1 starting from offset 00 to the offset specified by the Battery Data Block Size.

Offset 55 – End Indicator

This one byte field is always set to A5h, and may be checked by the power manager to assure that the block is in fact ending.

Generator Data

The Generator Data information block is used to describe generator devices. Generator devices are very similar to source devices in the sense that they can only provide power. However, they have the extra requirement of needing potentially needing a jump start before they are capable of providing power. This block will generally only be used by fuel cells and remote generators that do not contain their own internal start up batteries.

Offset	**Size**	**Values**	**Description**	**Notes**
00	1 Byte	Block Dependant (fah max)	Generator Data Block size, in bytes, minus checksum and End Indicator.	Permits ID block to grow, so pwr mgr can skip over unknown fields
01	1 Byte	07h	Block Identifier	Indicates that this is a Generator Data block.
02	1 Byte	0-ffh	Unique Node Id	Identifies this block, see description
03	1 Byte	00-f0	Device Icon	Special icons that should be displayed (see description)
04	1 Byte	00-0a	Device Priority	How important this device is (see description)
05	4 Bytes	00h-ffffffffh	Minimum Voltage	Specified in millivolts, this is the minimum sustainable voltage. No minimum is signified with 0h.
09	4 Bytes	00h-ffffffffh	Maximum Voltage	Specified in millivolts, this is the maximum sustainable voltage.
13	4 Bytes	00h-ffffffffh	Maximum Current	Specified in milliamps, this is the current entering the power manager above which the port should disable to protect the attached equipment.
17	4 Bytes	00h-ffffffffh	Peak Power	The peak power that the load device will draw.

21	2 Bytes	00h-ffffh	Maximum Ramp Rate	Specified in milliamps, this is the maximum rate at which current can be drawn (see description).
25	4 Bytes	00h-ffffffffh	Minimum Jumpstart Voltage	Minimum voltage in millivolts the system needs to start
29	4 Bytes	00h-ffffffffh	Maximum Jumpstart Voltage	The maximum voltage in millivolts the system can accept
33	2 Bytes	00h-ffffh	Minimum Jumpstart Current	Minimum current in milliamps that will be required to start
35	4 Bytes	00h-ffffffffh	Maximum Jumpstart Current	Maximum current in millamps that will be required to start
39	4 Bytes	00h-ffffffffh	Maximum Jumpstart Power	Maximum power in milliwatts that will be required to start
43	2 Bytes	00h-ffffh	Maximum Jumpstart Timeout	Expected maximum time to start the system, in seconds.
47	4 bytes	See Description	Unique Properties	See description
48	1 Byte	00-ffh	8-bit CRC	x8 + x2 + x + 1 of all ID bytes up to the byte prior to this one.
49	1 Byte	A5h	End Indicator	Permits checking that the size byte was read correctly.

Offset 00 – Generator Data Block size

This byte field, an unsigned integer, indicates the total number of header bytes, minus the final checksum and Generator Data End Indicator. This permits the addition of new fields without breaking earlier implementations.

If the power manager reads a Generator Data Block size larger than the number of fields it knows how to decode, it must use the first fields (the one it knows the function of), and then skip the remaining fields, except that it must include the skipped fields in calculating its checksum.

Offset 01 – Block Identifier

This byte field, an unsigned integer with value 07h, indicates that this is a Generator Data block. Since no specific block order is specified, the system must read this byte before processing the remainder of the block. If the system does not recognize the block, it must ignore the remainder of the block, and use the length field at offset 00 to determine the starting location of the next block.

Offset 02 – Unique Node Identifier

This bye field is used by the power manager to make logical connections between blocks in the cable and physical connections between blocks and circuits. For example, if a single port on a power manager has two logical circuits, the power manager will use the Unique Node Identifier to determine the order of attached devices. Furthermore, the Unique Node is used by the Smbus Block to associate its data with a specific block. For example:

A Power Manager has one physical port that has three separate electrical connections inside of it. The first connection is designed as an output, the second is designed as an input, the third is defined as an output. The cable associated with that port would have three blocks, a Load Block, a Source Block and another Lock Block. The first load block would have a Unique Identifier of 0, the source block would have a 1 and the second load block would have a 2. Additionally, if there were smbus data associated with the source block, it would use 1 as its Associated Node Block.

This allows the blocks to be put into the cable in any order but the power manager still knows the logical order in which to connect them.

Offset 03 – Device Icon

This field can be used to indicate that a certain icon should be displayed to the user. It is an optional field that has no effect on system operation and is purely information for the user. If it is unused it should be set as 0, which will allow the power manager to display an image of its own choosing (or none at all). To make it easier for new gear to support both old cables and new cables, the values will match those found in the legacy definition. The legacy definitions previously stored this information in the upper 4 bits of the Device Type in the Output block, so the values will seem a bit odd:

ID	Device Icon
16	AC Adapter
32	Solar Blanket
48	Vehicle Power
64	Fuel Cell
80	Radio
96	Laptop

112	Battery
128	Fan

Values above 240 are reserved for internal Power Manager use, so it can easily set things to display warnings, errors or as default images if none is specified here.

Offset 04 – Default Device Priority

This field is used to determine the priority of the device. These are the default settings that are used unless changed by the user.

Priorities affect generators identically to how they affect sources.

Offset 05 – Minimum Voltage

This is the minimum voltage that this device is capable of producing. Should the voltage drop below that point the power manager can assume that it is not present or is incapable of providing power.

Offset 09 – Maximum Voltage

This is the maximum voltage that this device is capable of producing. If the device is outputting higher than this value it may be damaged. Additionally the power manager can use this field to protect itself as not all power managers may be able to accept the full voltage range of all devices.

Offset 13 – Maximum Current

This field represents the number of milliamps that the device is capable of providing. At no point should the power manager attempt to draw more power than this from the device.

Offset 17 – Peak Power

This is the peak power that a device is capable of providing in milliwatts. Note, unlike the Peak Power field in the legacy Output Block, this field is NOT in 10's of milliwatts. Therefore a value of 10,000 would be 10W, whereas it would be 100W in the legacy Output block.

This field is not applicable all generator devices and should be entered as 0. However, certain devices may have a maximum power rating that is independent of the amount of current they can provide. Many converters function in this manner. If the device has an independent power limit, then enter that value into this field.

Offset 21 – Maximum Ramp Rate

Some devices are incapable of going from zero power to maximum power instantly and must instead be stepped up slowly. This field represents the maximum step size in

milliamps that that the power manager must adhere to when attempting to pull power from this device. This is not applicable for most devices and should be entered as 0.

Offset 25 – Minimum Jumpstart Voltage

This field specifies in millivolts the minimum voltage the generator requires for it to start up its internal processes.

Offset 29 – Maximum Jumpstart Voltage

This field specifies in millivolts the maximum voltage the generator can accept to start up its internal processes.

Offset 33 – Minimum Jumpstart Current

This field specifies in milliamps the minimum amount of current that the generator will require during start up. If the device is drawing less than this than it is either not present or no longer requires a jumpstart.

Offset 35 – Maximum Jumpstart Current

This field specifies in milliamps the maximum amount of current that the generator will require during start up. This is intended as a safety limit.

Offset 39 – Maximum Jumpstart Power

This field specifies in milliwants the maximum amount of power that the generator will require during start up. The power manager can use this field to determine whether or not it is capable of starting it.

Offset 43 – Maximum Jumpstart Timeout

This field specifies in seconds the expected maximum amount of time it should take the generator to start up. If it takes longer than this amount the power manager should stop providing power to it as the generator is unlikely to ever start up.

Offset 47 – Unique Properties

This byte is used to indicate if the generator has any unique properties that need to be taken into account. Each bit in the byte represents a different property. A device may have more than one bit set if appropriate. The properties for generators are very similar to the properties for sources.

1st bit (0x01) Backwards current protection present

2nd bit (0x02) Current Limited

3rd bit (0x04) Remote Starter

Example:

If a device had both backwards current protection and current limited, it would have the value 0x03 (0x01 + 0x02) entered into this field.

Explanation of bits:

Backwards current protection present: A device that protects itself and prevents itself from being damaged by backwards current flow will have this bit set. An example of this is the BA5590. If is it connected to a power manager, the system knows that it doesn't have to protect it if current should attempt to flow into it, it will protect itself. This is an important safety feature as not all devices have it built in. For example, if an AC Adapter were plugged into a power manager and was providing power at 15V, the adapter could be damaged if another device was hooked up that pulled the system's voltage above 15V. Current may attempt to flow into the AC Adapter, damaging it.

Current Limited: If a device has the Current Limited bit set, than that means it is capable of regulating its own output to prevent too much current from being drawn. This bit will generally be set on Fuel Cells.

Remote Starter: This field is generally used by power generators (such as fuel cell systems) in monitoring situations. This cable bit means that the power generator should start (or stop) based upon whether or not a voltage is present (based upon minimum jumpstart voltage). This allows it to be remotely controlled by another system.

Offset 48 – 8-bit CRC

This one byte CRC is calculated by using a simple CRC-ATM scheme with the polynomial x8 + x2 + x + 1 starting from offset 00 to the offset specified by the Generator Data Block Size.

Offset 49 – End Indicator

This one byte field is always set to A5h, and may be checked by the power manager to assure that the block is in fact ending.

Smbus Data

The Smbus Data block is used to specify that an attached device is capable of smbus communication. It is linked with one of the previously defined blocks so that the power manager knows precisely with which device it should attach information too.

Offset	**Size**	**Values**	**Description**	**Notes**
00	1 Byte	Block Dependant (fah max)	Smbus Data Block size, in bytes, minus checksum and End Indicator.	Permits ID block to grow, so pwr mgr can skip over unknown fields
01	1 Byte	08h	Block Identifier	Indicates that this is a Smbus Data block.
02	1 Byte	0-ffh	Linked Node Id	Links this block with another in the cable, see description
03	1 Byte	00-7fh	Smbus Address	Smbus address that can be used to contact a Smbus Capable device.
04	1 Byte	0-ffh	Number of SmBus Devices	The number of SmBus devices attached to the cable. See description for more details.
05	1 Byte	0-ffh	Smbus Mux Address	The base address any SmBus muxes in use. See description for more details.
06	1 Byte	0-ffh	Smbus Mux Offset	The necessary offset of any SmBus muxes in use. See description for more details.
07	1 Byte	00-ffh	Max Discharge Temp	Maximum internal temperature in C that a battery can be discharged too. No limit is ffh
08	1 Byte (Signed)	-126 through 127 (00-ffh)	Min Charge Temp	Minimum internal temperature in C for the battery to safely accept a charge. Range is -119 - +127. No limit is -120 or lower.

09	1 Byte (Signed)	-126 through 127 (00-ffh)	Max Charge Temp	Maximum internal temperature in C for the battery to safely accept a charge. Range is -119 - +127. No limit is -120 or lower.
10	1 Byte	See Description	Smbus Required Mask	Which devices are Smbus required
11	1 Byte	00-ffh	8-bit CRC	x8 + x2 + x + 1 of all ID bytes up to the byte prior to this one.
12	1 Byte	A5h	End Indicator	Permits checking that the size byte was read correctly.

Offset 00 – Smbus Data Block size

This byte field, an unsigned integer, indicates the total number of header bytes, minus the final checksum and Smbus Data End Indicator. This permits the addition of new fields without breaking earlier implementations.

If the power manager reads a Smbus Data Block size larger than the number of fields it knows how to decode, it must use the first fields (the one it knows the function of), and then skip the remaining fields, except that it must include the skipped fields in calculating its checksum.

Offset 01 – Block Identifier

This byte field, an unsigned integer with value 08h, indicates that this is a Smbus Data block. Since no specific block order is specified, the system must read this byte before processing the remainder of the block. If the system does not recognize the block, it must ignore the remainder of the block, and use the length field at offset 00 to determine the starting location of the next block.

Offset 02 – Linked Node Id

This field is used to link a set of Smbus data with a specific block defined elsewhere in the cable definition. The Unique Node Id of the associated block is what should be placed in this field.

For example, if a cable has a definition for a load device with Unique Node ID 0 and a battery device with a Unique Node ID of 1, this would contain a 0 if the smbus data was to be used with the load device, and a 1 if it were to be used with the battery device.

Offset 03 – Smbus Address

This field is used to declare the Smbus address of an Smbus capable device. Note, this is the 7-bit address before bit-shifting.

If the device responds to more than a single address, this field specifies the primary address (further Smbus data blocks can be generated to talk to the other addresses).

Offset 04 – Number of Smbus Devices

This field is the number of Smbus devices attached to this cable. For any Smbus capable devices, a value of zero or one means there is only one device attached. Any value above one is the number of devices attached. This comes into play in the case of the BB-2590. There are two halves to the battery, each with their own Smbus interface. There may, in the future, be other devices that have more than two Smbus interfaces on them.

Offset 05 – Smbus Mux Address

If a device has more than one Smbus interface to it, such as the BB-2590, and there is a way to communicate with both sides, then there is likely a mux in between that allows the Power Manager to communicate with both sides. This field contains the address of the mux. Note, this is the 7-bit address before bit-shifting.

Offset 06 – Smbus Mux Offset

Many Smbus muxes have an offset that must be logical or'd with any channel switches. If such an offset exists, it is placed in this field.

Offset 07 – Max Discharge Temp

This field is most commonly used on batteries, but it may be applicable on certain other devices. If it is not applicable then ffh should be entered.

When batteries become too hot they can be damaged or even explode if they are discharged. This field represents the maximum temperature in C that a battery can be at and be safely discharged. Any temperature above this and the Power Manager should disable the port.

Offset 08 – Min Charge Temp

This field is most commonly used on batteries, but it may be applicable on certain other devices. If it is not applicable then -120 or lower should be entered as this is an 8-bit signed field.

When batteries become too cold they can be damaged or even explode if they are charged. This field represents the minimum temperature in C that a battery must be at before it can start being charged. Any temperature below this and the Power Manager should disable charging on the port. This is a signed 8-bit field, so the valid range is -119 through +127.

Offset 09 – Max Charge Temp

This field is most commonly used on batteries, but it may be applicable on certain other devices. If it is not applicable then -120 or lower should be entered as this is an 8-bit signed field.

When batteries become too hot they can be damaged or even explode if they are charged. This field represents the maximum temperature in C that a battery can attain and still be safely charged. Any temperature above this and the Power Manager should disable charging on the port. This is a signed 8-bit field, so the valid range is -119 through +127.

Offset 10 – Smbus Required Mask

This field is used to specify that Smbus communication is required with a device before it can be used.

Each bit in the field is used to specify that a specific device needs to be talked too. In the case of only one device being talked to (no mux is present) that only the lowest bit, 0x01, will be used. If more than one device is present, any number of bits can be set.

For example, suppose there is a device that had 4 separate Smbus interfaced behind a mux. If only the first and third devices were required to communicate, this field would contain 0x5.

Offset 11 – 8-bit CRC

This one byte CRC is calculated by using a simple CRC-ATM scheme with the polynomial x8 + x2 + x + 1 starting from offset 00 to the offset specified by the Smbus Data Block Size.

Offset 12 – End Indicator

This one byte field is always set to A5h, and may be checked by the power manager to assure that the block is in fact ending.

Behavior

The following behaviors are specified for all power managers which comply with this specification.

Startup

At system startup, any compliant power manager shall initialize all programmable power outputs to the off state. Prior to turning power on, the power manager shall ascertain:

1) Is an IntelliCable connected?
2) What is the desired output?

If no cable is connected, the power manager shall not turn on the port. It is acceptable for a power manager to provide a user-initiated override and turn on the port to a programmed voltage, but this should not be the default behavior.

Operation

During operation, the power manager may periodically check to ascertain if the cable is still connected. If it is not, the power manager should turn off the voltage on that port.

Error Handling

1) Should any power manager detect a checksum error in any block read from an IntelliCable, that power manager may retry reading the cable. It is up to the power manager vendor to determine the number of retries and any other mechanisms that a power manager may use in order to coax a valid data read from a cable.
2) No power manager shall enable voltage or current on any port on which it has not read a valid checksum for each relevant block.
3) Should a power manager read an errored cable definition or ID block after a valid block has already been written and the port enabled, the power manager shall immediately remove power from the affected port, since the cable may have been swapped or damaged, resulting in the error. The power manager may choose to re-read the cable information prior to disconnecting power to the port, removing power only after some number of errors are observed.

4) When using the new format that can include multiple block types, it is up to the vendor to decide what they want to do. For example, if a cable contains two load blocks but one of them contains a CRC error, the vendor may choose what to do based upon their system architecture.

5) If any Block Size is read as being greater than 0xFA (250 decimal) then an error has occurred

Defined Ports

The following ports have been defined for use with IntelliCable specified cables:

BAO – 10-24V

The Battlefield Air Operations power manager uses a 10 pin Glenair Mighty Mouse connector with default keying. Pin 9 is specified as the IntelliCable pin. A BAO Power Manager must support a minimum output range of from 12-18V, although some power managers may provide a wider range.

Output currents up to 5A are supported by BAO power managers, although many have lower current capabilities at elevated temperatures.

Soldier Power: 5-34V

The Air Force standard Soldier Power Manager uses a 7 pin Glenair Mighty Mouse Connector, using alternative keying distinct from the Land Warrior battery specification, and the Li-145 battery. Pin 3 is defined as the IntelliCable pin.